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Fairness in Primary Care Procurement Measures of Under-Doctoredness: Sensitivity Analysis and Trends

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Fairness in Primary Care Procurement Measures of Under-Doctoredness: Sensitivity Analysis and Trends

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Glossary

ADS	Attribution Data Set
DH	Department of health
GMS	General Medical Service
GP	General Physician
NPCRDC	National Primary Care Research and Development Centre
ONS	Office for National Statistics
PCT	Primary Care Trust
PMS	Personal Medical Services
SLLTI	Standardised Limiting Long-Term Illness
SMR (<65)	Standard Mortality Ratio (for those aged under 65)
WTE	Whole Time Equivalent

Executive summary

The White Paper *Our Health, Our Care, Our Say* noted concerns about geographical equity of access to GPs (Department of Health, 2006, page 63), listed the 30 PCTs with the lowest number of GPs per head of need adjusted population, and set out policy initiatives to attract additional providers of general practice services to these PCTs.

We were asked to evaluate the impact of these policies on the bottom 30 PCTs and will report in Autumn 2010. In this report we consider a number of related measurement issues which are relevant for consideration of policy on equality of access to general practice.

Robustness of PCT rankings

GP provision per head of need adjusted population is measured as

$$\text{GPs}_{\text{perhead}} = \frac{\text{GPs}}{\text{need weights} \times \text{raw population}} \times 100,000$$

There are reasonable alternative definitions of "GPs", needs, and population. We examined how sensitive rankings of PCTs and the set of 30 worst provided PCTs were to these alternative definitions.

- Using the White Paper measure of GPs (whole time equivalents, excluding registrars and retainers, as at March 2005) we found that the set of worst provided PCTs is not very sensitive to alternative needs and raw population measures. For 12 alternative need and population adjustments, only 3 of the White Paper PCTs are not in the 30 PCTs which appear most often in the bottom 30 over the 12 alternatives (Table 5).
- But GPs make up 30% of the staff in general practice and the mix of GPs, practice nurses, and other practice staff varies considerably across PCTs (Figure 6). Hence rankings of PCTs and the set of worst provided PCTs are much more sensitive to the definition of general practice staff (Tables 2, 9, 10; Figure 5).
- When the date at which GPs were measured was changed from March 2005 to September 2005, 23 of the White Paper's bottom 30 PCTs were still in the bottom 30 (Table 2) and measures of provision for different need weights and raw population were very highly correlated (Table 7).
- Measures of provision calculated using the White Paper definitions were also highly correlated between consecutive years (Table 12)

Robustness of measures of overall inequality in distribution

It is also of policy interest to know how the overall level of geographical inequality in GP distribution across all PCTs is changing over time. Overall inequality may be affected both by policies targeted at the worst provided PCTs and by more general policies, for example by increases in the overall supply of GPs.

We used the Gini coefficient as the measure of overall inequality of distribution of GPs per need adjusted population across the 303 PCTs. We examined the effect of alternative definitions of GPs, need, population on the Gini coefficient. We found (Table 20):

- the Gini is insensitive to the definition of "GPs"
- the Gini is greatly affected by the choice of need adjustment and population measure. Using the White Paper definition of GPs, the Gini is greatest when the need adjustment is the Standardised Mortality Ratio and the population is measured by GP lists. It is smallest when the need adjustment is by consultation rate and the White Paper population measure is used.

We also examined trends in the Gini

- recent (2002-2005) trends are similar across alternative measures of GP provision per need adjusted population
- they all suggest a very small trend increase in inequality (Table 21, Figure 8)
- data from 1974-2005 suggest, allowing for breaks in the series caused by changing definitions and NHS administrative geography, that inequality has not fallen since the mid 1980s and may have increased slightly (Figure 9)

Conclusion

Our main conclusion is that whilst the set of worst provided PCTs varies, sometimes substantially, with the choice of GP supply measure, need adjustment, and population base, the set of 30 identified by the White Paper contains a core of around 10 PCTs which are amongst the worst provided on most possible alternative definitions. The White Paper set also contains a larger fringe group which are in the bottom 30 on some definitions, particularly when the White Paper definition of GPs is used, but which also often fall outside the worst provided bottom 30.

There is no obviously right set of definitions of GPs, need adjustments, and populations which can be implemented with available data. Judgements are required and those underlying the White Paper seem not unreasonable. However, we suggest that consideration be given to broadening the definition of the general practice staff from GPs to include practice nurses and possibly non-clinical staff as well.

1. Introduction

The White Paper *Our Health, Our Care, Our Say* noted concerns about geographical equity of access to GPs (Department of Health, 2006, page 63) and provided a list of the bottom 30 (10 per cent) of PCTs with the fewest doctors.

These concerns have existed since the founding of the NHS and led to the establishment of the Medical Practices Committee in 1948 to regulate entry of GPs into areas. The MPC was abolished in 2002. Subsequent policy initiatives have aimed to address the issue of unequal distribution of GPs across England. One of these is the procurement of new capacity from a range of potential alternative providers, including the independent sector, social enterprises and cooperatives (Department of Health, 2006, page 67). Efforts have been made to provide central resources to support PCTs in nationally or locally led procurement initiatives.

If the policy is successful, it is expected that an impact in terms of improved access will be observed in the first wave of PCTs and that the procurement will be extended also to other waves of PCTs.

We have been asked by the DH to evaluate the impact of the procurement policy (see section 6 for a short description of what we plan to do.) The evaluation of the procurement policy cannot be undertaken until sufficient time has passed to allow for any impact of the policy to become apparent. In this report we consider a number of related topics (agreed with the DH) that provide useful insights into the issue of fairness in primary care:

(i) robustness of definitions of GP provision per head of need adjusted PCT population. We investigate this by constructing alternative measures of WTE GPs per 100,000 weighted population by combining different need adjustments, definitions of GPs and other primary care staff, and measures of population. We then compare the rankings of PCTs, including that from the White Paper definition of GP provision, to see how robust the set of most under-doctored PCTs is to different definitions.

(ii) trends for different measures of WTE GPs per 100,000 weighted population and the correlation of rankings of PCTs over the period 2002 – 2005

(iii) the robustness of measures of overall geographical inequality in provision across all PCTs to alternative measures of GP provision per need adjusted head of population

(iv) trends in inequality in the distribution of GPs between 2002 and 2005 and since 1974.

Investigating the robustness of the measures of under-doctoredness to alternative definitions of need, staff supply and population estimates allows us to examine the degree to which the DH can be assured that targeting specific PCTs it has identified as under-doctored is a sensible policy approach. If the sub-set of PCTs identified as under-doctored is fairly robust to alternative measures, such a policy approach is more justified than if the rankings change substantially according to the measures used.

It is also of policy interest to know how the overall level of geographical inequality in GP distribution across all PCTs is changing over time. Overall inequality may be affected both by policies targeted at the worst provided PCTs and by more general policies, for example by increases in the overall supply of GPs. Again it is important to know how robust overall inequality measures are to the definition of GP supply per head of need adjusted population and especially whether the definition affects the trend in inequality.

2. Robustness of measures

2.1 Measures of GP provision

The provision of GPs in PCTs is measured as a ratio

$$\text{GPs}_{\text{per head}} = \frac{\text{GPs}}{\text{weighted population}} \times 100,000$$
$$= \frac{\text{GPs}}{\text{need weights} \times \text{raw population}} \times 100,000 \qquad (1)$$

To construct alternative measures of provision we use combinations of:

- Different need adjustments: based on age, gender, morbidity, and mortality;
- Different types of GPs and measures of other staff working in primary care: such as GPs (excluding and including registrars and retainers), practice nurses, the rest of the staff working in the practice, community nurses;
- Different population measures (revised Census data, patient lists, the White Paper estimate)

The data sources are described in the Appendix.

Following the White Paper we focus on the 30 PCTs (10% of pre 2006 PCTs) with the lowest number of WTE GPs per 100,000 weighted population.

2.1.1 GPs

GPs are the most salient type of staff who deliver services in primary care but other staff also provide services. Hence we consider the implications of extending the definition of "GPs" to include practice nurses, community nurses and other practice staff. We also consider alternative sets of GPs.

We have 9 different measures of "GPs" (see Appendices for further details):

- WTE GPs excluding registrars and retainers as at March 2005. This is the measure used in the White Paper.
- WTE GPs excluding registrars and retainers as at September 2005;
- WTE GPs including registrars and retainers as at September 2005;
- WTE GPs excluding registrars and retainers, plus practice nurses as at September 2005;
- WTE GPs including registrars and retainers, plus practice nurses as at September 2005;
- WTE GPs excluding registrars and retainers, plus all staff working in the practice as at September 2005;
- WTE GPs including registrars and retainers, plus all staff working in the practice as at September 2005;
- WTE GPs excluding registrars and retainers, plus all staff working in the practice and community nurses as at September 2005;
- WTE GPs including registrars and retainers, plus all staff working in the practice and community nurses as at September 2005.

Given the relatively small numbers of registrars and trainees and community nurses we expect that inclusion or exclusion of these categories will have relatively little effect on measures of provision unless they are much more unequally distributed than the other categories of staff.

2.1.2 Population

A number of alternative measures of population are available. We use three different measures of raw population (see Appendix for further details):

- 2001 Census data, as revised by the Office of National Statistics (ONS) in 2003;
- GMS patient list data, which is the population based on the GP patient lists in practices affiliated to each PCT. Typically the total population on GP lists in a PCT is greater than the total population as estimated from Census data. Differences vary across PCTs and by age and gender categories.
- GP relevant population, which is the population based on GP patient lists in practices affiliated to each PCT but rescaled so that the total population equals the ONS estimated population for the PCT. This is the raw population used in the White Paper.

It is not obvious which is the best measure of population to use in assessing provision of GPs. Counting only patients on GP lists could be misleading if poor provision of GPs led to a smaller proportion of the total population being registered with GPs. If so using GP list populations would tend to underestimate differences in the availability of GPs for the whole population. On the other hand the Census estimates may themselves be inaccurate counts of the total population. Such inaccuracies are likely to become more important the greater the time since the full Census count. If the inaccuracies are systematic in the sense of being related to characteristics of the population such as its age structure or population turnover then use of Census will also lead to inaccurate measures of the population.

2.1.3 Needs adjustment

Population measures unadjusted for variations in the "needs" of the population would be misleading when comparing the supply of primary care services in PCTs and therefore it is routine to try to adjust for need in some way. Such adjustments most often consider the age and gender mix of the PCT population and measures of morbidity and mortality.

We select 4 need adjustments (see Appendix for further details):

- The age-sex and need adjustments used in the DH Global Sum Allocation Formula (Department of Health, 2004). The raw population is first multiplied by an age-sex workload index and by a measure of additional needs based on standardised long term limiting illness ratio (SLLTI) and standardised mortality ratio for under 65s (SMR<65). The resulting population is then scaled so that the sum is equal to the unweighted population in England. The age-sex adjusted population is then multiplied by the additional needs adjusted population and scaled back. This is the adjustment used in the White Paper.
- SLLTI only. The raw population is first multiplied by the SLLTI ratio and then scaled back so that the sum is equal to the unweighted population in England.
- SMR<65 only. The raw population is multiplied by the SMR<65 and then scaled back so that the sum is equal to the unweighted population in England.
- Consultation rates. Age and gender specific national consultation rates are used to weight the PCT populations. Consultations are defined as the number of contacts with a clinician per patient registered with a practice (Hippisley-Cox et al., 2007).

The adjustment for the age and gender structure of the population and for the additional needs of the population, relating to morbidity and mortality, reflect the different workload generated by different age-sex groups on the practice list and the additional workload generated by patients with a high severity. The age and gender specific national consultation rates give an alternative measure of the workload based on the expected number of times patients in different age and sex groups see a GP.

In principle the need adjustment should relate to the population's capacity to benefit from services provided by GPs, which is probably best measured by morbidity. Consultation rates are affected by morbidity but also by supply factors (consultation rates may be higher in areas with more GPs per

head) and by factors such as patient education. If supply and non-need factors are correlated with age and gender mix across practices then the age and sex specific consultation rates will be an inaccurate measure of relative need. However, existing morbidity measures such as SLLTI and SMR are rather crude. Thus it is not obvious which of our four possible need adjustments is the most appropriate.

The White Paper weighted population measure was calculated using the age-sex workload and additional need adjustment applied to the GP relevant population. The Department of Health supplied us with the weighted populations calculated for all PCTs. We were however unable to reproduce these weighted populations (the denominator in the White Paper GPs per head measure) exactly using DH supplied separate measures of the age-sex workload, additional needs and GP relevant populations. However, our replication of the White Paper weighted population denominator is very close. The correlation coefficient between the measure of GPs per head which underlies the White Paper and our replication is 0.9995 (N=303) and our replication identifies exactly the same 30 PCTs as the most under-doctored. (See Appendix B for further discussion.)

2.2 Sensitivity analysis: overview

Once we have built the alternative measures of need adjusted supply of GPs per head of population, we proceed by ranking all 303 PCTs by these measures and we focus on the bottom 10 per cent of PCTs with the fewest doctors (30 PCTs). We then count the number of times a PCT is under-doctored according to the different measures of need adjusted supply of GPs per head of population. Designation of a PCT as under-doctored is more robust the more times the PCT is in the bottom 30.

Table 1 lists the 30 PCTs designated as the worst provided in the White Paper.

Table 1. 30 PCTs designated as worst provided in the White Paper

PCT	WTE GPs per 100,000 weighted population	Rank
North Manchester PCT	40.61	1
Wyre PCT	43.18	2
Ashfield PCT	43.64	3
Trafford North PCT	43.80	4
Swale PCT	43.84	5
Oldham PCT	43.98	6
Mansfield District PCT	44.06	7
Doncaster West PCT	44.20	8
Walsall PCT	44.34	9
Knowsley PCT	44.53	10
Wolverhampton City PCT	44.71	11
Doncaster East PCT	44.95	12
Ashton, Leigh And Wigan PCT	45.09	13
Burnley, Pendle And Rossendale PCT	45.15	14
Barking And Dagenham PCT	45.19	15
Blackpool PCT	45.31	16
North Stoke PCT	45.51	17
Eastern Hull PCT	45.52	18
Wednesbury And West Bromwich PCT	45.66	19
Tendring PCT	46.30	20
Barnsley PCT	46.39	21
Easington PCT	46.45	22
Shepway PCT	46.46	23
Hastings And St Leonards PCT	46.73	24
North Kirklees PCT	46.87	25
Southport And Formby PCT	47.31	26
South Tyneside PCT	47.42	27
Oldbury And Smethwick PCT	47.45	28
Hartlepool PCT	47.47	29
Blackburn With Darwen PCT	47.54	30

With the data available we construct 117 measures of GPs per head. There are 9 choices of numerator – the measures of "GPs" (one in March 2005, eight in September 2005). There are three population measures and four need adjustments which produce 12 possible need adjusted populations, plus the White Paper weighted population, to make a total of 13 measures for the denominator.

Table 2 shows the number of the White Paper bottom 30 PCTs which are in the bottom 30 of PCTs on the 117 measures of GP provision per need adjusted population. Each of the nine columns has a different GP supply measure and each of the 13 rows has a different need adjusted population.

The White Paper GPs per head measure results from the numerator in column 1 and the denominator in row 0. Comparisons along row 0 shows the effect of alternative GP provision measures combined with the White Paper weighted population measure. Row 2 is our replication of the White Paper and comparison with row 1 shows that our replication differs negligibly from the White Paper.

Reading along row 0 shows that when the White Paper definition of GPs is used but the count is taken in September 2005 (column 2), rather than in March 2005 as in the White Paper, 23 of the White Paper 30 are in the bottom 30. This suggests that the designation of a PCT as under-doctored is quite sensitive to a six month change in the date at which GPs are counted. We investigate this further in section 2.4 (Table 7).

Comparison of definitions of "GPs" which differ only in whether registrars and retainers are counted (for example between columns 2 and 3 or 4 and 5) shows that these types of GP have relatively little impact on whether a PCT is designated as under-doctored. This is unsurprising given the relative small number of these types of GP.

The inclusion of practice nurses has a bigger impact than registrars and retainers (eg columns 2 and 4) but the biggest change arises when the measure of "GPs" is expanded to include all staff. However, community nurses make very little difference because of their small number.

Reading down column 1 gives the effect of combining alternative need and population measures with the White Paper count of GP provision. The impact of using a particular population count depends on which need adjustment it is combined with (and vice versa). For example, comparison of rows 1, 2 and 3 might suggest that the use of the Census count rather than the GP relevant population as in the White Paper, dramatically reduces the number of White Paper PCTs appearing in the bottom 30. But this is only so when the age-sex workload and additional need adjustments are used. With the SLLTI (rows 5 to 7) or SMR (rows 7 to 9) need adjustments the effect of switching from the GP relevant population to the Census population is much smaller.

2.3 Sensitivity analysis using GPs measured at March 2005

We now examine in more detail the implications of alternative need adjustments and population counts combined with the White Paper definition of WTE GPs counted in March 2005. These yield the 12 measures of GPs per capita shown in rows 1 to 12, column 1 of Table 2.

- gp_dh_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- gp_dh_census in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the Census population;
- gp_dh_patients in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the GMS patient list population;
- gp_sllti_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SLLTI adjustment and *raw population* is the GP relevant population;
- gp_sllti_census in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SLLTI adjustment and *raw population* is the Census population;
- gp_sllti_patients in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SLLTI adjustment and *raw population* is the GMS patient list population;

Table 2: Number of White Paper PCTs in the bottom 30 PCTs according to different measures of GPs per head of need adjusted population

	March GPs	**September GPs**							
	1. GPs excluding registrars and retainers (White Paper)	2. GPs excluding registrars and retainers	3. GPs including registrars and retainers	4. GPs excluding registrars and retainers plus practice nurses	5. GPs including registrars and retainers plus practice nurses	6. All staff excluding registrars and retainers	7. All staff including registrars and retainers	8. All staff excluding registrars and retainers plus community nurses	9. All staff including registrars and retainers plus community nurses
0. White Paper weighted population	30	23	22	16	18	7	8	7	8
1. GP relevant population - Age-sex and need adjustments	30	23	22	16	18	6	8	6	8
2. Census population - Age-sex and need adjustments	11	12	11	9	8	5	5	5	5
3. GMS patient list population - Age-sex and need adjustments	27	22	21	15	17	4	7	4	7
4. GP relevant population - SLLTI adjustment	21	20	18	17	16	9	10	9	10
5. Census population - SLLTI adjustment	19	18	17	16	17	11	11	11	11
6. GMS patient list population - SLLTI adjustment	21	18	18	16	17	7	9	7	9
7. GP relevant population - SMR adjustment	17	17	17	15	14	7	7	7	7
8. Census population - SMR adjustment	19	17	17	13	14	7	8	7	8
9. GMS patient list population - SMR adjustment	14	14	13	11	11	5	6	6	7
10. GP relevant population – consultation adjustment	17	13	16	10	9	2	3	2	3
11. Census population – consultation adjustment	11	9	10	7	6	3	3	3	3
12. GMS patient list population – consultation adjustment	7	8	7	4	4	2	2	2	2

- gp_smr_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SMR adjustment and *raw population* is the GP relevant population;
- gp_smr_census in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SMR adjustment and *raw population* is the Census population;
- gp_smr_patients in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SMR adjustment and *raw population* is the GMS patient list population;
- gp_qresearch_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the QRESEARCH adjustment and *raw population* is the GP relevant population;
- gp_qresearch_census in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the QRESEARCH adjustment and *raw population* is the Census population;
- gp_qresearch_patients in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the QRESEARCH adjustment and *raw population* is the GMS patient list population.

gp_dh_dh is our replication of the White Paper measure. It identifies exactly the same 30 PCTs as under-doctored as the White Paper and is extremely highly correlated with the White Paper measure of GPs per capita.

In order to explore the sensitivity of rankings of under-served PCTs to the use of these alternative measures, we proceed as follows. For each of the 12 measures, we build an indicator variable taking value 1 for the first 30 mostly under-doctored PCTs and value zero for the remaining PCTs. In order to calculate the number of times a PCT is mostly under-doctored for all the 12 measures, we sum these 12 indicator variables by PCT. The resulting measure is a variable taking values between 0 (for all 12 alternative measures, a PCT is never under-doctored) and 12 (for all 12 alternative measures, a PCT is always under-doctored).

Figure 1 is a histogram (frequency distribution) of the count of the number of times (out of 12) a PCT is in the bottom 30. If the concept of under-doctoredness was completely robust then the 30 most under-doctored PCTs identified by the White Paper would be under-doctored (in the bottom 30) for all 12 measures and the remaining PCTs would never be in the bottom 30. The histogram would then have a spike with a frequency of 30 at 12 times under-doctored and zero height in 1 to 11 times under-doctored.

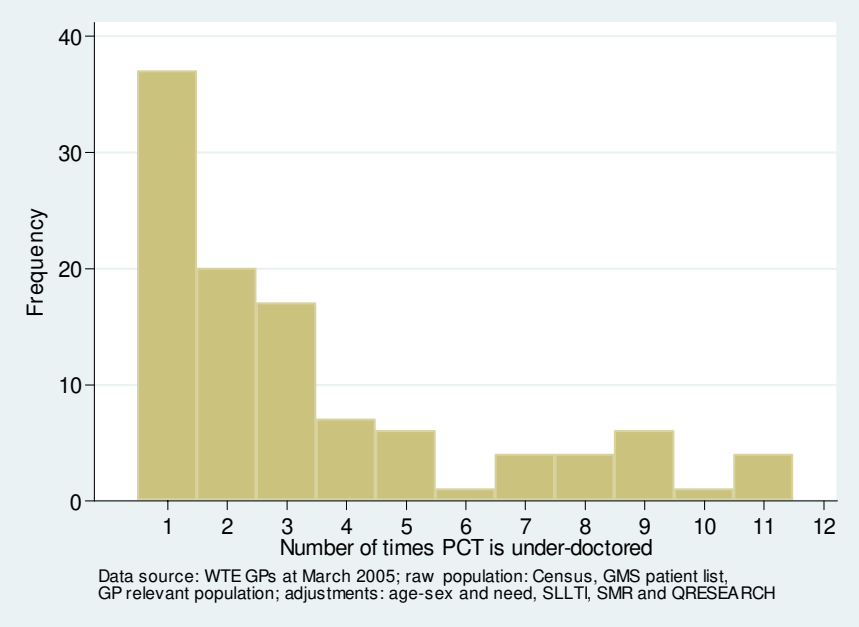

Figure 1: Number of times a PCT is in the bottom 30 of PCTs ranked by March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 measures of need adjusted population

Figure 1 shows that, using 12 measures of GPs per head of population, 37 of 303 PCTs are under-doctored only once, 20 are under-doctored twice, 17 are under-doctored three times and so on. No PCT is under-doctored twelve times.

Table 3 shows that the 30 PCTs identified as the most under-doctored in the White Paper figure are much more often in the bottom 30 across the 12 measures of GPs per capita than the remaining 273 PCTs. The White Paper PCTs are more consistently found to be under-doctored than the remaining PCTs.

Table 3: Mean number and percentage of times White Paper PCTs are in the bottom 30 of PCTs ranked by March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 measures of need adjusted population

	Mean number of times in bottom 30 ((out of a maximum of 12)	Mean % of times in bottom 30-
White Paper bottom 30	7.13	59
All other PCTs	0.53	4
All PCTs	1.19	10

Table 4 shows the number of times out of 12 each White Paper under-doctored PCT is in the bottom 30. There is a very wide range (92% to 25%) in the percentage of times a PCT has been classified as under-doctored.

Table 4: Number of times White Paper PCTs are in bottom 30 of PCTs ranked by March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 measures of need adjusted population

White Paper PCT	Number of times in bottom 30 (max 12)	% of times in bottom 30
Walsall	11	92
Trafford North	11	92
Wolverhampton City	11	92
Barking and Dagenham	11	92
Eastern Hull	10	83
Mansfield District	9	75
Ashton, Leigh & Wigan	9	75
North Stoke	9	75
Oldham	9	75
Ashfield	9	75
North Manchester	9	75
Hartlepool	8	67
Knowsley	8	67
Burnley, Pendle and Rossendale	8	67
Doncaster East	8	67
North Kirklees	7	58
Blackburn with Darwen	7	58
Blackpool	7	58
Doncaster West	7	58
Swale	6	50
Easington	5	42
Barnsley	5	42
Oldbury & Smethwick	5	42
Wednesbury and West Bromwich	4	33
Shepway	4	33
Wyre	4	33
Tendring	4	33
Hastings & St Leonards	3	25
South Tyneside	3	25
Southport & Formby	3	25

Table 5 shows the most consistently under-doctored PCTs among all 303 PCTs. Only three PCTs (in bold) which are not in the White Paper bottom 30 are shown to be in the most consistently under-doctored set.

Table 5: Number of times most consistently under-doctored PCTs are in bottom 30 of PCTs ranked by March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 measures of need adjusted population

PCT Name	Number of times in bottom 10 per cent (max 12)	% of times in bottom 10 per cent
Walsall	**11**	**92**
Trafford North	**11**	**92**
Wolverhampton City	**11**	**92**
Barking and Dagenham	**11**	**92**
Eastern Hull	**10**	**83**
Mansfield District	**9**	**75**
Ashton, Leigh & Wigan	**9**	**75**
North Stoke	**9**	**75**
Oldham	**9**	**75**
Ashfield	**9**	**75**
North Manchester	**9**	**75**
Hartlepool	**8**	**67**
Knowsley	**8**	**67**
Burnley, Pendle and Rossendale	**8**	**67**
Doncaster East	**8**	**67**
North Kirklees	**7**	**58**
Blackburn with Darwen	**7**	**58**
Blackpool	**7**	**58**
Doncaster West	**7**	**58**
Swale	**6**	**50**
Easington	**5**	**42**
Barnsley	**5**	**42**
Oldbury & Smethwick	**5**	**42**
Central Liverpool*	**5**	**42**
Heart of Birmingham Teaching*	**5**	**42**
Central Manchester*	**5**	**42**
Wednesbury and West Bromwich	**4**	**33**
Shepway	**4**	**33**
Wyre	**4**	**33**
Tendring	**4**	**33**

* Not in White Paper bottom 30.

Table 6 gives the coefficients of correlations (Spearman rank correlations) between the above 12 measures. The higher the correlation, the higher the correspondence between the rankings derived using different populations and/or adjustments.

2.3.1 Conclusions – measures with March 2005 GPs

Our analyses of measures of provision using March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 alternative measures of need adjusted population suggests

- Under-doctoredness, defined as being in the bottom 30 PCTs, is sensitive to the measure of need adjusted population.
- No PCT is under-doctored all twelve times.
- The White Paper 30 PCTs figure much more often in the bottom 30 across the 12 measures than the remaining 273 PCTs.
- Ten of the 30 White Paper PCTs feature in the bottom 30 PCTs less than 50% of the time (table 4)
- Only three PCTs that are not in the White Paper list feature in the most consistently under-doctored PCTs using all alternative definitions (table 5)
- Overall, although there is variation in the rankings, the White Paper PCTs are more consistently found to be under-doctored than the remaining PCTs.

Table 6: Coefficients of correlations for March 2005 WTE GPs (excluding registrars and retainers) per head of need adjusted population for 12 measures of need adjusted population

	gp_dh_dh	gp_dh_ census	gp_dh_ patients	gp_sllti_ dh	gp_sllti_ census	gp_sllti_ patients	gp_smr_ dh	gp_smr_ census	gp_smr_ patients	gp_qrese arch_dh	gp_qrese arch_ census	gp_qrese arch_ patients
gp_dh_dh	1											
gp_dh_census	0.684	1										
gp_dh_patients	0.600	0.965	1									
gp_sllti_dh	0.430	0.850	0.880	1								
gp_sllti_census	0.415	0.883	0.910	0.940	1							
gp_sllti_patients	0.350	0.831	0.899	0.928	0.985	1						
gp_smr_dh	0.264	0.776	0.845	0.928	0.885	0.900	1					
gp_smr_census	0.239	0.788	0.857	0.851	0.924	0.937	0.939	1				
gp_smr_patients	0.175	0.724	0.827	0.821	0.889	0.927	0.930	0.988	1			
gp_qresearch_dh	0.535	0.616	0.557	0.505	0.338	0.281	0.418	0.241	0.186	1		
gp_qresearch_census	0.515	0.748	0.675	0.468	0.468	0.398	0.406	0.390	0.321	0.823	1	
gp_qresearch_patients	-0.103	0.448	0.550	0.451	0.506	0.553	0.589	0.631	0.660	0.343	0.547	1

2.4 Sensitivity analysis using September 2005 GPs

In this section we repeat the previous analysis but using measures of GP provision at September 2005, rather than March 2005, to enable us to also examine the implications of using alternative measures of "GPs" as well as alternative population counts and need adjustments.

2.4.1 Comparison of March and September 2005 GP measure

First we look at the correlation between the 12 measures that we are able to calculate using both March and September data. (These are the measures in columns 1 and 2, rows 1 to 12 in Table 2.) Table 7 reports Spearman rank correlation coefficients for each pair of rankings (March-September) for each of the 12 measures:

Table 7: Correlation coefficients between rankings based on March and September data on WTE GPs excluding registrars and trainees

Definition of need adjusted population	Correlation between rankings using March and September 2005 GP data
age-sex and need adjustment, Census population	0.984
age-sex and need adjustment, GP relevant population	0.966
age-sex and need adjustment, GMS patient list	0.963
SLLTI adjustment, Census population	0.988
SLLTI adjustment, GP relevant population	0.987
SLLTI adjustment, GMS patient list	0.988
SMR adjustment, Census population	0.988
SMR adjustment, GP relevant population	0.987
SMR adjustment, GMS patient list	0.989
QRESEARCH adjustment, Census population	0.961
QRESEARCH adjustment, GP relevant population	0.930
QRESEARCH adjustment, GMS patient list	0.942

It can be seen from Table 7 that the correlations between the rankings based on GP data from March and September are generally very high, in most cases higher than 0.95. Thus a six month difference in the date at which GP provision is measured makes little difference to the overall rankings of PCTs. Notice, however, that the change in date reduced the number of White Paper PCTs in the bottom 30 to 23 (Table 2, columns 1,2, rows 0, 1).

2.4.2 Comparison using September 2005 GP measures

We next consider 96 different measures of GPs per head of population using September data:

8 measures of GPs × 3 measures of population × 4 need adjustments

Figures 2 and 3 are constructed in the same way as Figure 1. They show, for a given definition of GP provision, the effects of the alternative 12 measures of need adjusted population. Each histogram shows the number of times, out of 12, a PCT was in the bottom 30. The histograms are very similar to Figure 1 and show that under-doctoredness is sensitive to the need adjustment whatever the measure of GP provision.

Figure 4 combines the information from Figures 2 and 3 and shows the number of times, out of 96, that a PCT was in the bottom 30. Table 8 compares the extent to which the White Paper bottom 30 and all other PCTs are in the bottom 30 according to the 96 alternative measures of GPs per need adjusted head of population. The White Paper 30 are much more likely to be in the bottom 30 than other PCTs.

Table 9 shows the number of times out 96 the White Paper bottom 30 are in the bottom 30 and Table 10 shows the 30 PCTs which are most consistently in the bottom 30 over the 96 measures.

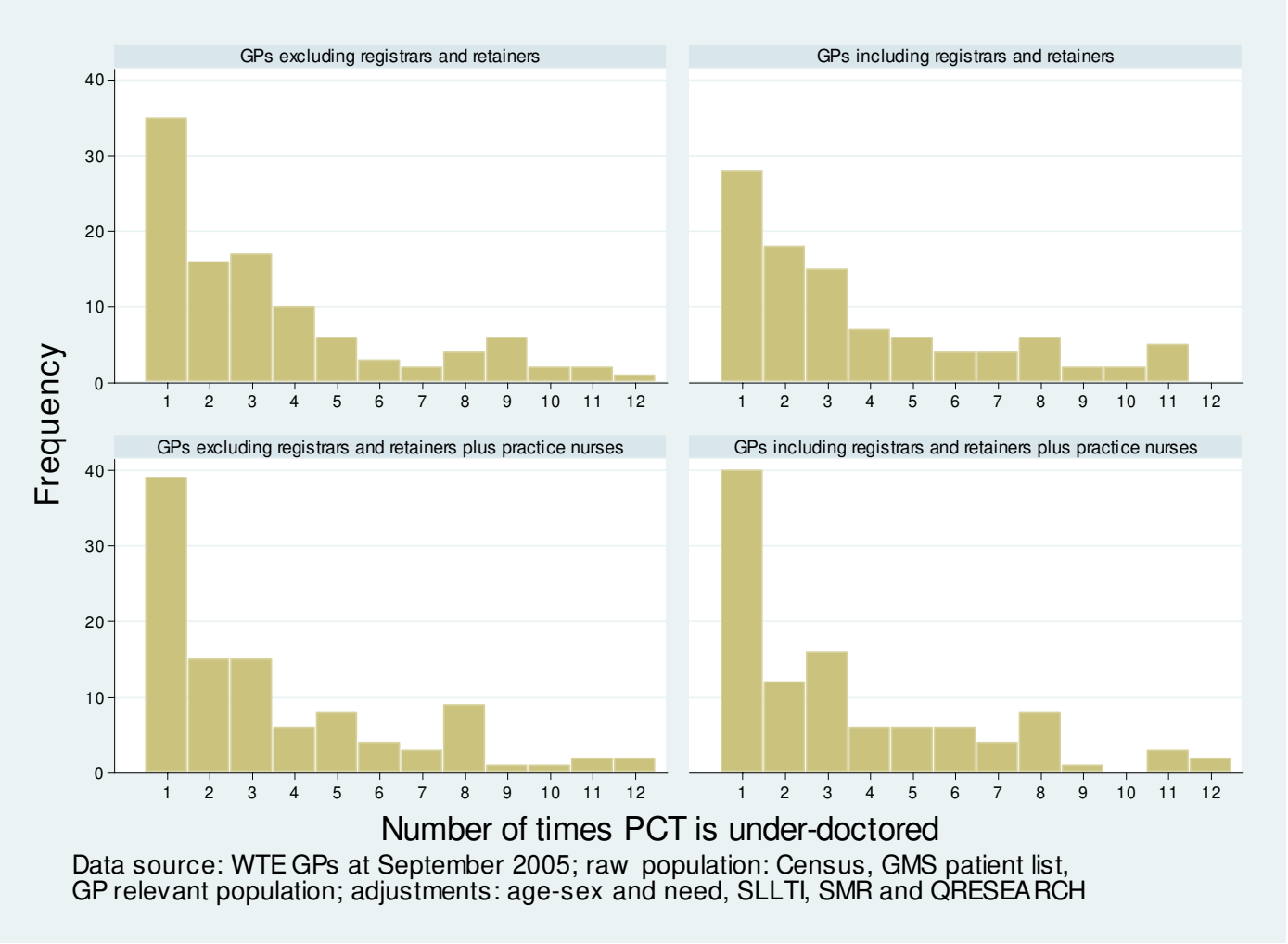

Figure 2: Number of times a PCT is in the bottom 30 of PCTs ranked by September 2005 GPs and practice nurses per head of need adjusted population for 12 measures of need adjusted population

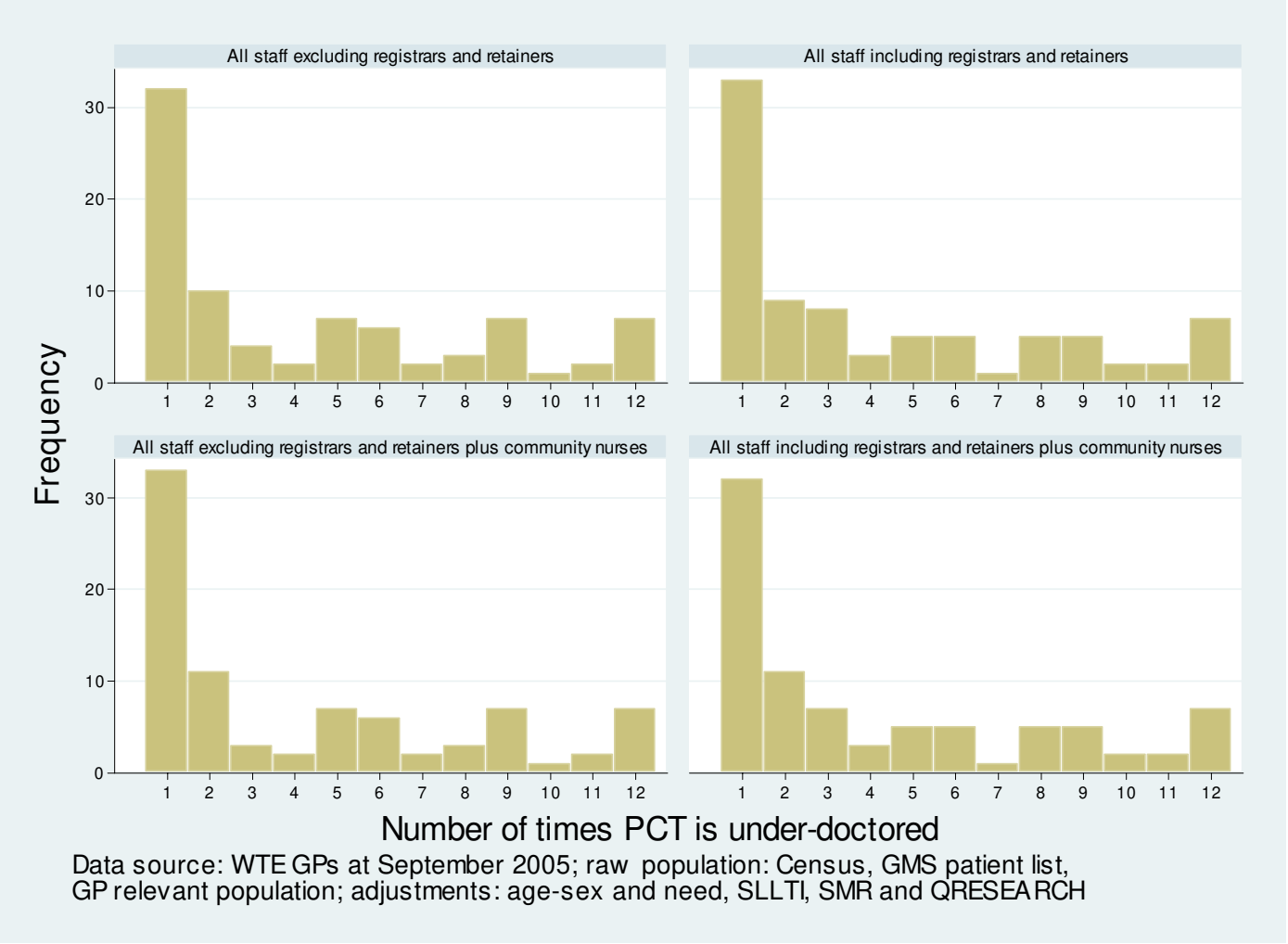

Figure 3: Number of times a PCT is in the bottom 30 of PCTs ranked by September 2005 all practice staff (GPs, practice nurses, administrative staff, community nurses) per head of need adjusted population for 12 measures of need adjusted population

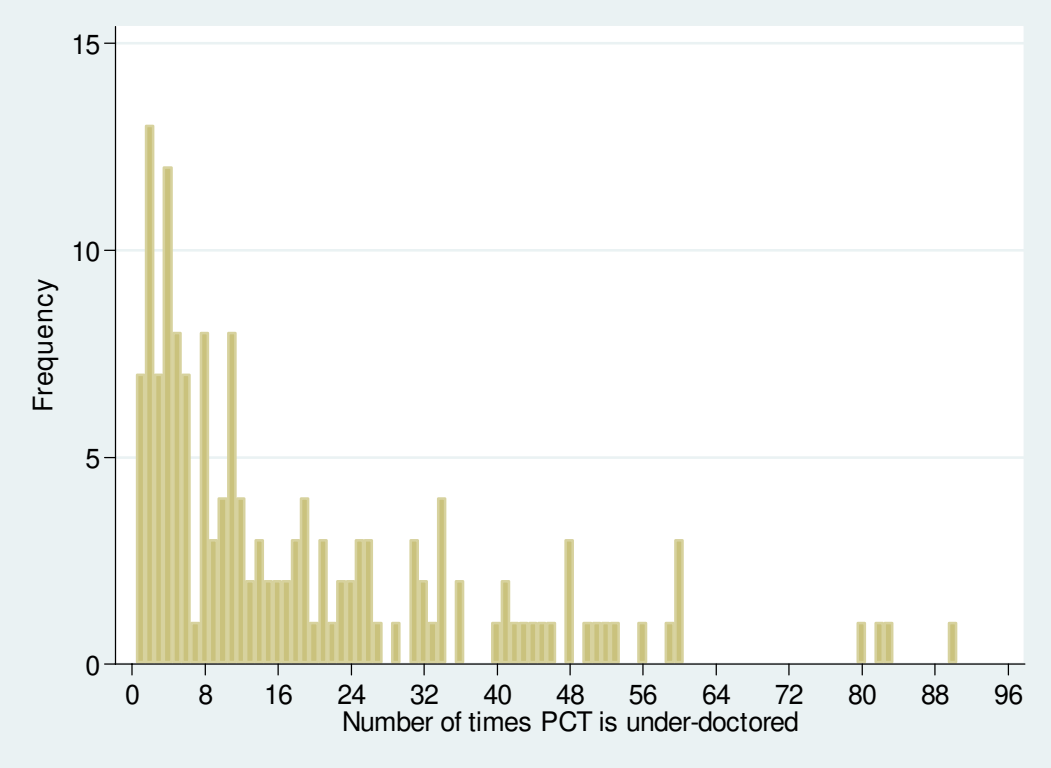

Figure 4: Number of times a PCT is in the bottom 30 of PCTs ranked by September 2005 "GPs" per need adjusted population for 96 combinations of GP provision and need adjusted population

Table 8 shows that the 30 PCTs identified as the most under-doctored in the White Paper figure more often in the bottom 30 across the 96 measures of GPs per capita than the remaining 273 PCTs. This implies that the White Paper PCTs are more consistently found to be under-doctored than the remaining PCTs.

Table 8: Mean number and percentage of times PCTs are in the bottom 30 of 96 rankings of September 2005 per capita GP provision.

	Mean number of times in bottom 30 (out of a maximum of 96)	Mean % of times in bottom 30
White Paper bottom 30	32.47	34
All other PCTs	6.98	7
All PCTs	9.50	10

Table 9 shows the degree to which the White Paper bottom 30 PCTs are also in the bottom 30 using our 96 alternative measures of September 2005 "GPs" per capita. There is a very wide range in the percentage of times a PCT has been classified as under-doctored ranging from 94% (Wolverhampton City) to 0% (South Tyneside).

Table 10 shows the most consistently under-doctored PCTs among all 303 PCTs. Nearly two thirds (19/30) of the most consistently under-doctored PCTs are not in the White Paper bottom 30 PCTs (highlighted in bold).

Table 9: Number of times White Paper PCTs are in bottom 30 of PCTs ranked by September 2005 GPs per need adjusted population for 96 combinations of GPs and need adjustment.

PCT	Number of times in bottom 30 (max 96)	% of times in bottom 30
Wolverhampton City	90	94
North Manchester	83	86
Barking and Dagenham	80	83
Knowsley	60	63
Walsall	60	63
Ashfield	51	53
Trafford North	43	45
Eastern Hull	36	38
Hartlepool	34	35
Mansfield District	34	35
Blackpool	34	35
Oldham	33	34
Blackburn with Darwen	32	33
North Stoke	32	33
Swale	31	32
Ashton, Leigh & Wigan	29	30
Barnsley	27	28
Easington	25	26
Shepway	24	25
Wyre	20	21
Doncaster East	18	19
North Kirklees	18	19
Burnley, Pendle and Rossendale	18	19
Doncaster West	17	18
Tendring	14	15
Hastings & St Leonards	13	14
Southport & Formby	11	11
Oldbury & Smethwick	4	4
Wednesbury and West Bromwich	3	3
South Tyneside	0	0

Table 10: Number of times PCTs are in bottom 30 of PCTs ranked by September 2005 GPs per need adjusted population for 96 combinations of GPs and need adjustment.

PCT Name	Number of times in bottom 10% (max 96)	% of times in bottom 10%
Wolverhampton City	90	94
North Manchester	83	86
South Sefton*	**82**	**85**
Barking and Dagenham	80	83
Knowsley	60	63
Walsall	60	63
Central Manchester*	**60**	**63**
Heywood & Middleton*	**59**	**61**
Sunderland Teaching*	**56**	**58**
Mendip*	**53**	**55**
Halton*	**52**	**54**
Ashfield	51	53
Barnet	**50**	**52**
Rowley Regis & Tipton*	**48**	**50**
Northumberland*	**48**	**50**
Mid Devon*	**48**	**50**
Slough*	**46**	**48**
Dudley: Beacon & Castle*	**45**	**47**
South Somerset*	**44**	**46**
Trafford North	43	45
Hammersmith and Fulham*	**42**	**44**
North Birmingham*	**41**	**43**
Castle Point & Rochford*	**41**	**43**
Heart of Birmingham Teaching*	**40**	**42**
Eastern Hull	36	38
Lambeth*	**36**	**38**
Hartlepool	34	35
Mansfield District	34	35
Blackpool	34	35
Bradford City*	**34**	**35**

*Not in the White Paper bottom 30

Out of the 96 measures of per capita GPs, we select the following 13 measures for further analyses:

- gp_dh_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- gp_dh_census in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the Census population;
- gp_dh_patients in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the GMS patient list data;
- gp_sllti_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SLLTI adjustment and *raw population* is the GP relevant population;
- gp_smr_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the SMR adjustment and *raw population* is the GP relevant population;
- gp_qresearch_dh in which *GPs* is WTE GPs excluding registrars and retainers, *need weights* is the QRESEARCH adjustment and *raw population* is the GP relevant population;
- gpnurse_dh_dh in which *GPs* is WTE GPs excluding registrars and retainers but including practice nurses, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- gptot_dh_dh in which *GPs* is WTE GPs excluding registrars and retainers but including all staff working in the practice, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- gptotnu_dh_dh in which *GPs* is WTE GPs excluding registrars and retainers but including all staff working in the practice and community nurses, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- allgp_dh_dh in which *GPs* is WTE GPs including registrars and retainers, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- allgpnurse_dh_dh in which *GPs* is WTE GPs including registrars, retainers and practice nurses, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- allgptot_dh_dh in which *GPs* is WTE GPs including registrars, retainers and all staff working in the practice, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population;
- allgptotnu_dh_dh in which *GPs* is WTE GPs including registrars, retainers, all staff working in the practice and community nurses, *need weights* is the age-sex and need adjustments and *raw population* is the GP relevant population.

gp_dh_dh uses the White Paper definitions of GPs, population and need adjustment. gp_dh_census and gp_dh_patients have been selected to see how much of the correlation is explained by different measures of raw populations with respect to the benchmark measure. gp_sllti_dh, gp_smr_dh and gp_qresearch_dh have been selected to see how much of the correlation is explained by different need adjustments with respect to the benchmark measure. The final seven measures have been selected to see how much of the correlation is explained by different measures of supply with respect to the benchmark White Paper measure.

Table 11 reports the rank correlation coefficients for these selected 13 measures based on all 303 PCTs. The pattern of correlations is consistent with our comments on Table 2 which focussed on the number of times the White Paper bottom 30 appeared in the bottom 30 on other definitions of “GPs”, need adjustment and population. The biggest differences in rankings occur when the measure of “GPs” is extended to include practice nurses and other practice staff.

Figure 5 shows a set of scatter plots of 15 measures of GPs per head across all 303 PCTs. The measures are the White Paper measure for March 2005, our replication of the White Paper measure, and the above thirteen measures using September 2005 GP provision. The scatter plot in the top left hand corner is between the White Paper measure and our replication of it and shows that the replication is very nearly perfect.

The two scatter plots in the second row show the correlations between the White Paper measure, our replication of the White Paper measure and our measure based on September 2005 data. Comparison of the three left hand columns of the scatter plots shows that it makes almost no difference whether the original White Paper measure, our March 2005 replication, or the September 2005 version is used.

Table 11: Correlations for 13 measures of September 2005 “GPs" per head of need adjusted population

	gp_dh_dh	gp_dh_census	gp_dh_patients	gp_sllti_dh	gp_smr_dh	gp_qresearch_dh	allgp_dh_dh	allgpnurse_dh_dh	allgptot_dh_dh	allgptotnu_dh_dh	gpnurse_dh_dh	gptot_dh_dh	gptotnu_dh_dh
gp_dh_dh	1												
gp_dh_census	0.704	1											
gp_dh_patients	0.628	0.964	1										
gp_sllti_dh	0.432	0.874	0.899	1									
gp_smr_dh	0.259	0.779	0.843	0.922	1								
gp_qresearch_dh	0.537	0.760	0.689	0.465	0.394	1							
allgp_dh_dh	0.645	0.958	0.938	0.859	0.778	0.729	1						
allgpnurse_dh_dh	0.538	0.807	0.796	0.730	0.665	0.619	0.785	1					
allgptot_dh_dh	0.518	0.813	0.809	0.749	0.687	0.624	0.849	0.973	1				
allgptotnu_dh_dh	0.294	0.464	0.478	0.467	0.436	0.322	0.449	0.702	0.670	1			
gpnurse_dh_dh	0.293	0.465	0.479	0.467	0.439	0.326	0.451	0.700	0.670	0.998	1		
gptot_dh_dh	0.303	0.488	0.504	0.492	0.462	0.343	0.495	0.716	0.704	0.995	0.994	1	
gptotnu_dh_dh	0.302	0.488	0.503	0.491	0.463	0.345	0.494	0.713	0.701	0.993	0.995	0.9984	1

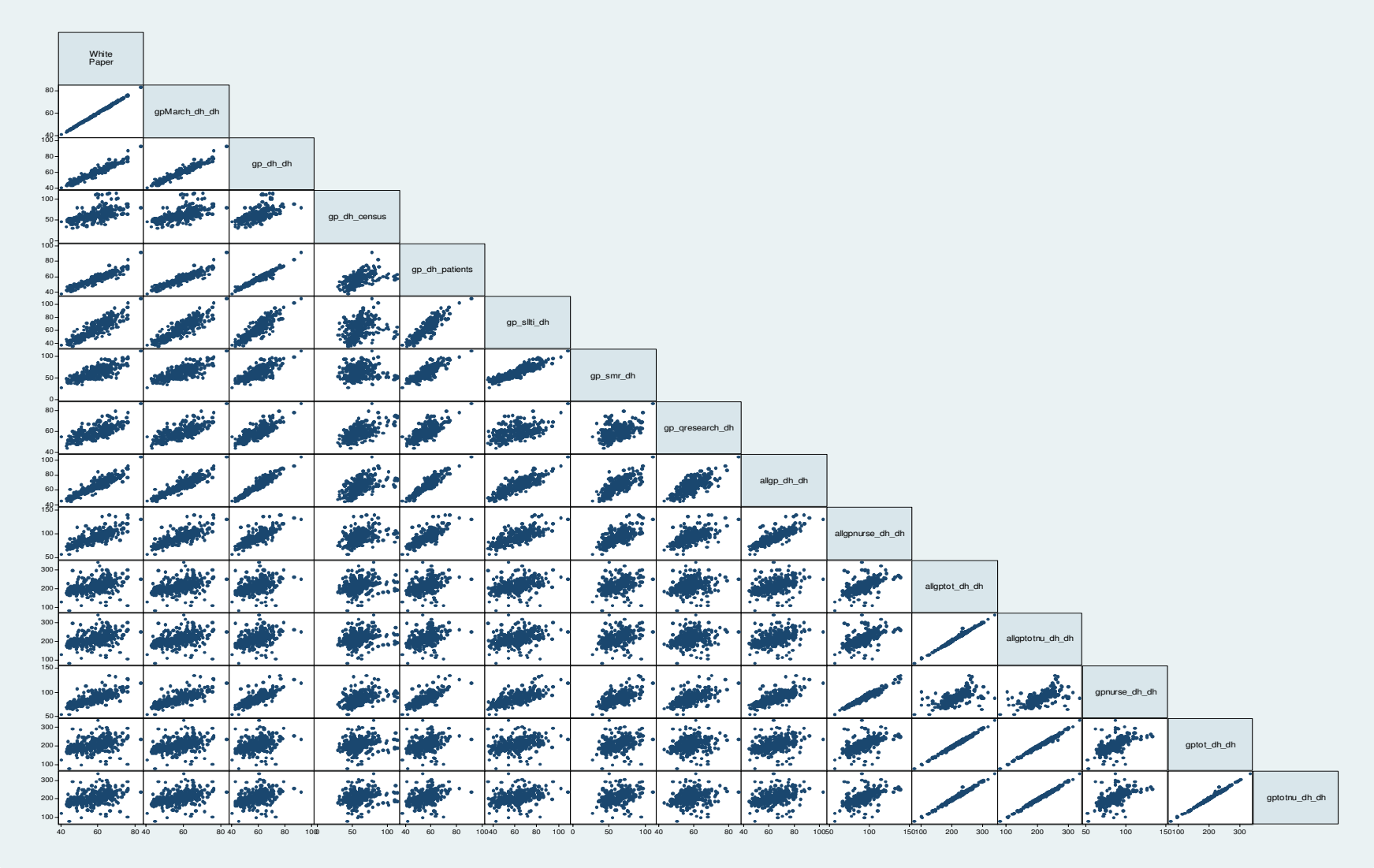

Figure 5: Scatter plot matrix for the White Paper and 14 measures of GPs per head of population

2.5 Variations in mix of practice staff

Figure 6 shows that there is considerable variation in the mix of practice staff across PCTs. The horizontal axis plots the percentage of total practice staff (WTE GPs excluding retainers and trainees, plus nurses, plus administrative staff at September 2005) accounted for by GPs, and the vertical axis plots the percentage accounted for by nurses. The percentage of staff accounted for by administrative staff for a PCT is shown by its vertical (or horizontal) distance from the downward sloping line with slope -1 between the 100% point on the two axes. If practices used nurses and GPs in fixed proportions then the points in the figure would lie on a ray from the origin.

The figure shows that a focus only on GPs could be misleading: the other staff who also provide services to patients and enhance the services provided by GPs are not proportional to the number of GPs. GPs as a proportion of staff vary from under 20% to over 70%. Thus, as suggested by the differences in rankings between measures with only GPs in the numerator and those with GPs and other types of practice staff, it may be sensible to consider non-GP staff when considering the adequacy of supply of services in general practice.

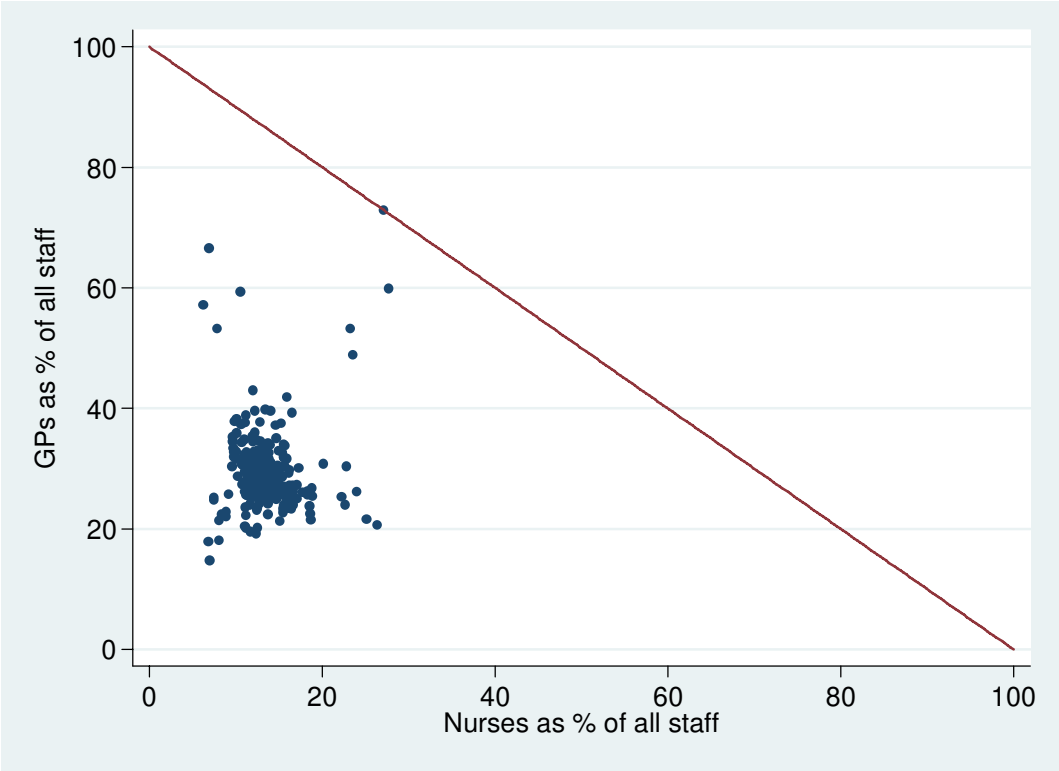

Figure 6. Variations in mix of practice staff across PCTs

2.6 Conclusions – results using GPs at September 2005

A broadly similar picture to that found when using just 12 alternative measures emerges using 96 measures. However, as might be expected, there are greater variations in the rankings produced and hence less robustness in the original White Paper listing. We find:

- The White Paper sub-set of 30 PCTs figure more often in the bottom 30 across the 96 measures of GPs per capita than the remaining 273 PCTs.
- Twenty-four of the 30 White Paper PCTs feature in the bottom 30 PCTs less than 50% of the time (table 9)
- Eleven of the White Paper PCTs feature in the most consistently under-doctored PCTs using all 96 alternative definitions (table 10).
- Because other staff are not distributed in proportion to GPs' rankings are quite sensitive to the inclusion of non-GP staff in the measure of provision.

- Overall, although there is variation in the rankings, the White Paper PCTs are more consistently found to be under-doctored than the remaining PCTs.

3. Changes in measures over time

The second part of the analysis looks at the distribution of GPs over time and at the potential impact on the ranking of PCTs between 2002 and 2005. It uses data on GPs and other primary care staff from September in the respective years.

First we look at trends in numbers of different types of GPs, practice nurses and other primary care staff over time. In Figure 7, each observation is the national sum of each measure of health care supply. All measures of supply have increased over time and in 4 years WTE practice staff have increased by around 5,880 people, with an average increment of 20 new employees per PCT. Out of these new 5,880 people employed, around 47% were GPs (+2,746 at national level, + 9 per PCT), 30% were nurses (+ 1,795 at national level, +6 per PCT) and the rest was administrative and other staff. The figure does not include community nurses who increased by less than 1 per PCT over this period. The figure reinforces our earlier remarks about the potential importance of non-GP staff: GPs are under a third of practice staff.

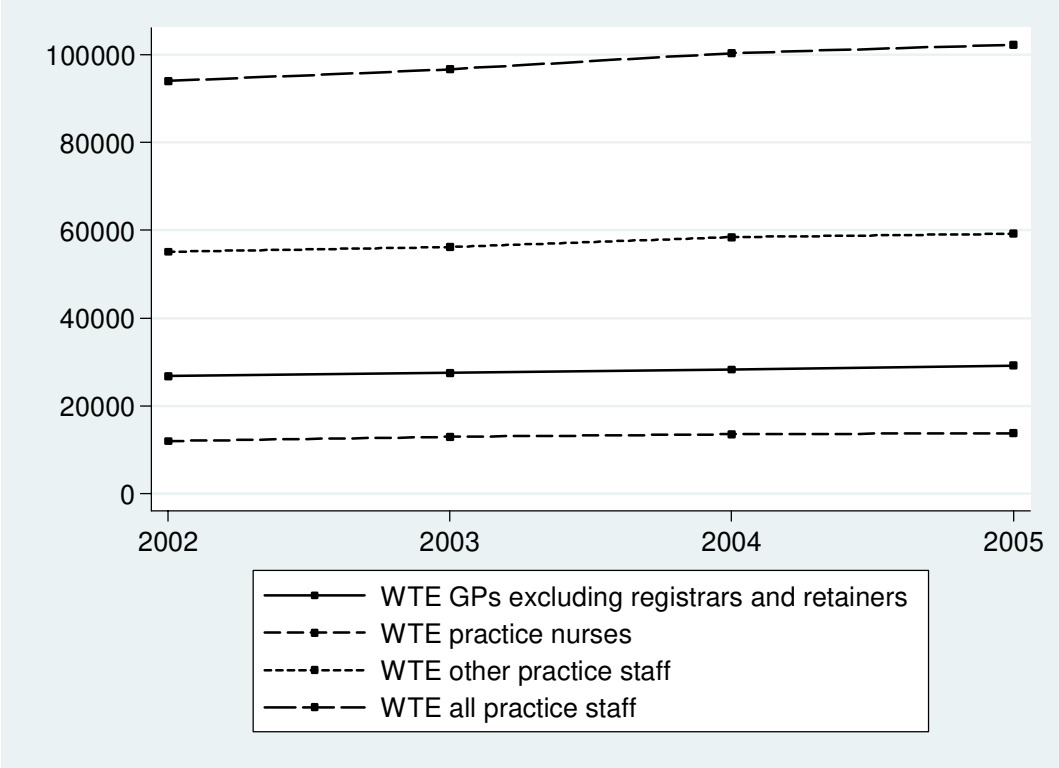

Figure 7: GPs and other staff 2002 – 2005

We now investigate the changes over time in the measures used in our analyses, first using the White Paper definition of GPs and then using broader definitions. Tables 12 to 15 report rank correlations over time between measures based on the WTE GPs excluding registrars and retainers (which is the same measure of GPs used in the White Paper), the GP relevant population and four different need adjustments (age-sex and need adjustment, SLLTI, SMR and QRESEARCH adjustments).

Table 12 shows the correlation of the replication of the White Paper measure over the four years.

Table 12: Correlation over time between measures based on WTE GPs excluding registrars and retainers, age-sex and need adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.929	1		
2003	0.877	0.904	1	
2002	0.834	0.855	0.910	1

Table 13: Correlation over time between measures based on WTE GPs excluding registrars and retainers, SLLTI adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.973	1		
2003	0.954	0.966	1	
2002	0.932	0.942	0.965	1

Table 14: Correlation over time between measures based on WTE GPs excluding registrars and retainers, SMR adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.976	1		
2003	0.957	0.968	1	
2002	0.933	0.946	0.966	1

Table 15: Correlation over time between measures based on WTE GPs excluding registrars and retainers, consultation rate adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.861	1		
2003	0.759	0.808	1	
2002	0.676	0.716	0.861	1

Use of the consultation rate adjustment leads to noticeably lower correlations over time than the other need adjustment.

Tables 16 to 19 use the broader definitions of staff and report the rank correlations between measures based on the WTE GPs including registrars, retainers, all staff working in the practice and community nurses (all primary care staff), the GP relevant population and four different need adjustments (age-sex and need adjustment, SLLTI, SMR and consultation rate adjustments).

Table 16: Correlation over time between measures based on all primary care staff, age-sex and need adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.660	1		
2003	0.588	0.697	1	
2002	0.586	0.653	0.743	1

Table 17: Correlation over time between measures based on all primary care staff, SLLTI adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.784	1		
2003	0.782	0.833	1	
2002	0.793	0.815	0.878	1

Table 18: Correlation over time between measures based on all primary care staff, SMR adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.800	1		
2003	0.786	0.854	1	
2002	0.792	0.828	0.885	1

Table 19: Correlation over time between measures based on all primary care staff, consultation rate adjustment and GP relevant population

	2005	2004	2003	2002
2005	1			
2004	0.633	1		
2003	0.588	0.641	1	
2002	0.531	0.580	0.687	1

It can be seen from the tables that in general the correlation between the measures based on the DH definition of GPs is high, indicating that the ranking of PCTs by provision of GPs will not change greatly over quite short periods provided that the need adjuster is not consultation rates. When using the wider measure of primary care staff, however, the correlations are lower and thus the rankings will be less stable over time.

3.1 Conclusions – analysis of trends over time

- Our analysis of changes over time (2002-05) suggests that the White Paper measures of GPs per head of need adusted population are highly correlated between consecutive years. Thus rankings of PCTs in terms of GPs per need adjusted population are likely to be fairly stable from one year to the next.
- Once a wider definition of supply is used (including nurses and other staff) the correlation is weaker.

4. Measures of overall inequality in distribution

In addition to identifying the set of most under-doctored PCTs it is useful for policy to have a measure of overall inequality in geographical distribution across all PCTs. Overal inequality will be affected both by policies aimed at the worst provided PCTs and by policies which for example increase the total number of GPs. We therefore consider the impact of alternative measures of GP provision per need adjusted population on a commonly used summary measure of inequality in distribution.

The measure of inequality is the Gini coefficient which is often used as a measure of inequality in income distribution and has been used previously as a measure of inquality in GP supply. The Gini coefficient takes a value of 1 (a single PCT has all the GPs) and zero (all PCTs have the same GPs per need adjusted population).

4.1 Sensitivity analysis

Table 20 reports the Gini coefficients for 108 possible measures of GP provision. The alternative measures are those in rows 1 to 12 of Table 2. Calculation of the Gini requires the raw population and so we cannot calculate Ginis for any measures in row 0 of Table 2 since we do not have the raw population count used to construct the original March 2005 White Paper measure, only the need adjusted population.

The choice of measure clearly has a considerable impact on the level of overall inequality. The Gini for our replication of the White Paper measure (row 1, column 1) is 0.075. The Gini is relatively insensitive across measures of GP provision (ie along rows) except for the consultation rate adjustments in rows 10 to 12. Reading down the columns shows that the Gini is more affected by the measure of weighted population. Thus with the March 2005 GP measure (column 1) the Gini varies between 0.054 (row 10) and 0.136 (row 9).

Table 20: Gini coefficients for different measures of GPs per head of need adjusted population

	March GPs	**September GPs**							
	1. GPs excluding registrars and retainers (White Paper)	2. GPs excluding registrars and retainers	3. GPs including registrars and retainers	4. GPs excluding registrars and retainers plus practice nurses	5. GPs including registrars and retainers plus practice nurses	6. All staff excluding registrars and retainers	7. All staff including registrars and retainers	8. All staff excluding registrars and retainers plus community nurses	9. All staff including registrars and retainers plus community nurses
1. GP relevant population - Age-sex and need adjustments	0.075	0.078	0.086	0.076	0.080	0.090	0.090	0.091	0.091
2. Census population - Age-sex and need adjustments	0.124	0.128	0.130	0.122	0.123	0.134	0.133	0.135	0.134
3. GMS patient list population - Age-sex and need adjustments	0.071	0.073	0.082	0.074	0.079	0.092	0.092	0.093	0.092
4. GP relevant population - SLLTI adjustment	0.123	0.124	0.131	0.120	0.125	0.127	0.127	0.127	0.128
5. Census population - SLLTI adjustment	0.127	0.127	0.134	0.125	0.129	0.130	0.130	0.131	0.131
6. GMS patient list population - SLLTI adjustment	0.124	0.124	0.132	0.123	0.128	0.132	0.132	0.132	0.132
7. GP relevant population - SMR adjustment	0.131	0.131	0.139	0.130	0.134	0.138	0.138	0.138	0.139
8. Census population - SMR adjustment	0.132	0.131	0.139	0.131	0.135	0.138	0.138	0.138	0.139
9. GMS patient list population - SMR adjustment	0.136	0.136	0.144	0.137	0.141	0.146	0.146	0.147	0.147
10.GP relevant population – consultation adjustment	0.054	0.058	0.066	0.065	0.067	0.088	0.086	0.089	0.087
11. Census population – consultation adjustment	0.068	0.071	0.077	0.079	0.080	0.098	0.097	0.099	0.097
12. GMS patient list population – consultation adjustment	0.064	0.064	0.073	0.080	0.083	0.106	0.105	0.107	0.106

4.2 Trends over time

Trends in Gini coefficients based on the same measures of GPs per need adjusted population are of more policy relevance than differences across measures at the same date. We have therefore calculated Gini coefficients for a subset of measures over the period 2002 to 2005 during which PCT boundaries were unchanged. The Gini coefficients are presented in Table 21. The first row are the Ginis for the White Paper definitions of GP supply per need adjusted population.

Table 21: Changes in the Gini coefficient over time

	2002	2003	2004	2005
WTE GPs excluding registrars and retainers, age-sex and need adjustment, GP relevant population (gp_dh_dh)	0.070	0.067	0.075	0.078
WTE GPs excluding registrars and retainers, SLLTI adjustment, GP relevant population (gp_sllti_dh)	0.115	0.113	0.123	0.124
WTE GPs excluding registrars and retainers, SMR adjustment, GP relevant population (gp_smr_dh)	0.121	0.121	0.130	0.131
WTE GPs excluding registrars and retainers, QRESEARCH adjustment, GP relevant population (gp_qresearch_dh	0.052	0.050	0.053	0.058
All primary care staff, age-sex and need adjustment, GP relevant population (tot_dh_dh)	0.077	0.070	0.092	0.091
All primary care staff, SLLTI adjustment, GP relevant population (tot_sllti_dh)	0.118	0.112	0.131	0.128
All primary care staff, SMR adjustment, GP relevant population (tot_smr_dh)	0.126	0.124	0.142	0.139
All primary care staff, QRESEARCH adjustment, GP relevant population (tot_qresearch_dh)	0.072	0.064	0.084	0.087

Figure 8 is a graphical representation of Table 21. It can be seen from the table and figure that all Ginis for all 8 measures have the same pattern over time. The Ginis fell between 2002 and 2003 (except for gp_smr_dh when it was unchanged) but then rose in the following two years and were higher in 2005 than in 2002.

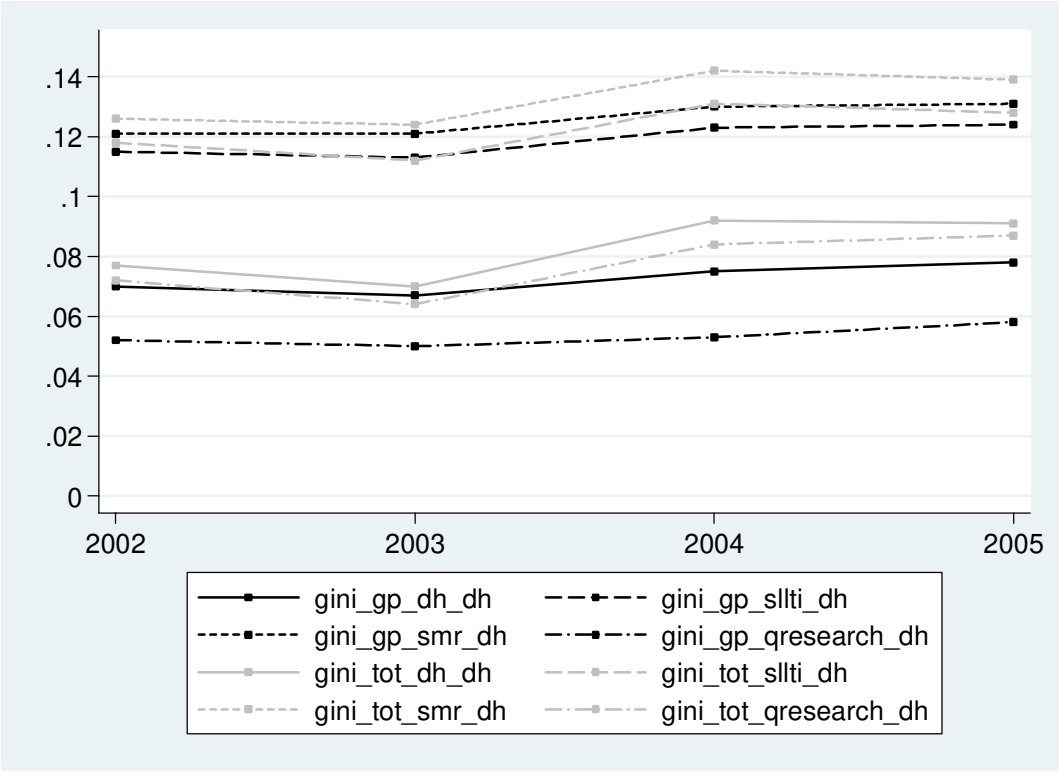

Figure 8: Trend in geographical inequality in distribution (Gini coefficients) of "GPs" measured 2002-2005 for a set of measures of GP provision per need adjusted population.

4.3 Longer term trends (1974-2005) in geographical inequality in GP distribution

We also investigated the longer-term trends in the distribution of GPs. Figure 9 graphs the Gini coefficient from 1974-2005 using the SLLTI, SMR and consultation rate based need adjustments. The data from 1974-2001 are taken from Hann and Gravelle (2004).

Comparisons over time are hampered by the changing administrative geography of the NHS. Ginis calculated over a larger number of areas will, all else held constant, show more inequality. The series for 1974-1995 are based on the distribution across 98 Family Health Service Authority (FHSAs). The series for 1994-2001 are based on 100 "frozen" Health Authorities (HA) whereas those for 2002 to 2005 are for 303 PCTs. Note that in the years 1994 and 1995 data at both FHSA and HA levels of aggregation are available.

The definition of GPs used also changes over the period. It was a count of unrestricted GP principals and equivalents for 1974-1995 and for 1994 to 2005 it was White Paper definition (all GPs excluding registrars and retainers).

Because of these differences, discontinuities in the graph can be observed when moving between levels of aggregation and GP types. These discontinuities do not represent changes in the level of inequality – they are artefacts of the data and the geography.

However, allowing for the discontinuities, it appears that there has been a broadly upward trend in the mal-distribution of GPs beginning in the mid-80s.

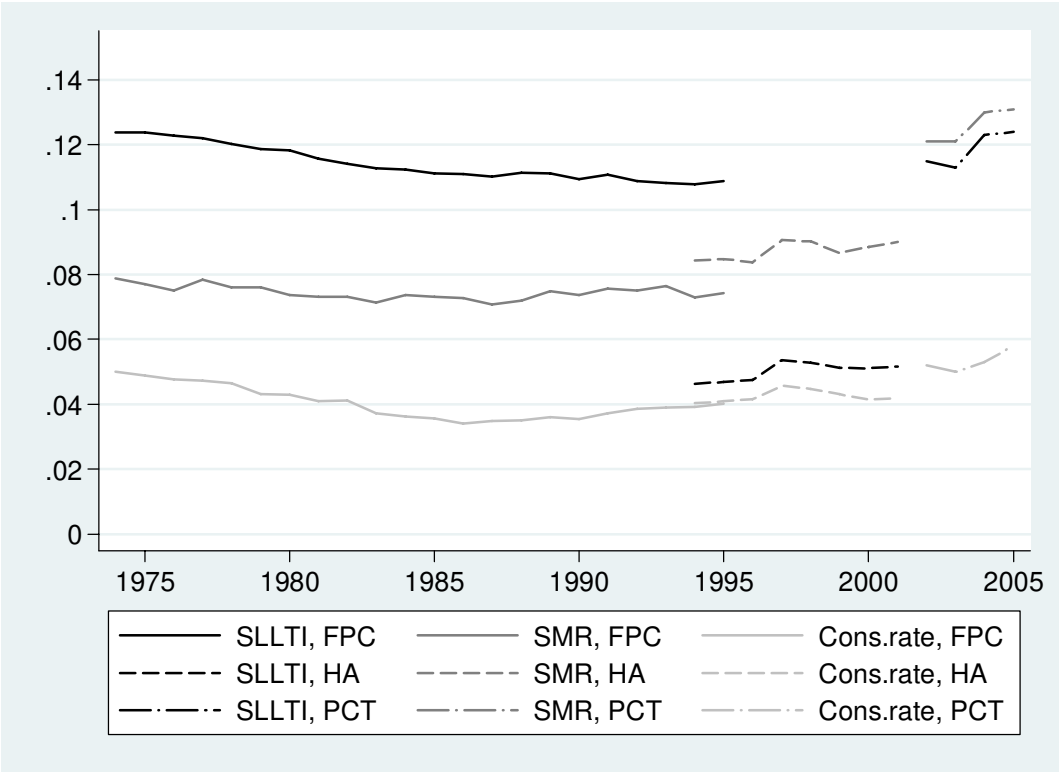

Figure 9: Trend in inequality in GP distribution as measured by the Gini coefficient over the period 1974-2005

4.3.1 Conclusions – analysis of trends over time

- Trends in inequality as measured by the Gini coefficient for alternative measures of GPs per need adjusted population are similar across all measures for the period 2002 to 2005, with inequality at first falling and then increasing.
- Analysis of the Gini index from 1974-2005 shows a broadly upward trend in inequality beginning in the mid 1980s, though the changes are proportionately fairly small.

5. Conclusions

Our main conclusion is that whilst the set of worst provided PCTs varies, sometimes substantially, with the choice of GP supply measure, need adjustment, and population base, the set of 30 identified by the White Paper contains a core of around 10 PCTs which are amongst the worst provided on most possible alternative definitions. The White Paper set also contains a larger fringe group which are in the bottom 30 on some definitions, particularly when the White Paper definition of GPs is used, but which also often fall outside the worst provided bottom 30.

There is no obviously right set of definitions of GPs, need adjustments, and populations which can be implemented with available data. Judgements are required and those underlying the White Paper seem not unreasonable. However, we suggest that consideration be given to broadening the definition of the general practice staff from GPs to include practice nurses and possibly non-clinical staff as well.

6. Future analyses

As outlined in the initial proposal agreed with the DH, we will undertake further analyses:

- Investigate associations between measures of GP provision and indicators similar to those contained in the balanced scorecard package, including patient satisfaction measures. We also will utilise other data e.g. waiting times for GP appointment, referral rates. We estimate this can be completed by Spring 2008.
- Investigate explanations for under-provision of GPs by looking at the association between our measures and a range of PCT-level variables. We will examine the factors which are associated with variations in GP supply per head of population to examine the extent to which actual supply varies with need (as measured in the various ways explored in this report) and with other PCT factors. For example, do social and income inequalities imply an unequal distribution of GPs? We estimate this can also be completed by Spring 2008.
- Evaluate changes over time and the impact of policies on improving access. A simple before and after comparison of the 30 PCTs will ignore changes that might have happened even in the absence of any policies to tackle access. In order to isolate the impact of the policy, we will therefore also examine what is happening over time generally in all other PCTs. We will quantify the change in indicators of access due to the policy intervention by examining the changes that occur over time in the 30 PCTs compared to changes that occur in other PCTs, employing a controlled before and after methodology (“difference in difference” methodology). We will only be able to do this when an appropriate period of time has passed to allow for the impact of the policy to become apparent. We anticipate an initial analysis by Spring 2009 and a fuller analysis by 2010.

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Appendix A: Data

The database consists of 303 Primary Care Trusts for the period 2002-2005 and contains approximately 190 variables and 1,213 observations. Data was extracted from the national primary care dataset developed by the NPCRDC merged with consultation rate data from the Information Centre and with data provided by the DH.

NPCRDC Dataset
Source: National Primary Care dataset, http://www.primary-care-db.org.uk/GET_DATA.cfm

GP services - GMS statistics
GMS Statistics contains summary data about general medical practitioners providing GMS in England, their patients, partnerships and services provided. We have used data on WTE GPs, including and excluding registrars and retainers, WTE practice nurses, WTE community nurses and WTE practice staff; and also data on patients registered with GPs by age and gender.

Demographic Data - 2001 ONS Census
2001 ONS Census contains a selection of demographic and socioeconomic data at PCT level that can be systematically linked to GMS data. We have used the population data by age and gender.

Department of Health data
Source: Roger Halliday, Analyst - Primary care and long-term conditions, Knowledge & Intelligence Team, Department of Health, Room 4E46, Quarry House, Leeds, LS2 7UE. Office: 0113-25-46160. roger.halliday@dh.gsi.gov.uk

GP relevant population
The 2005 (2004, 2003, 2002) GP relevant population is estimated using the GP patient lists in practices affiliated to each PCT and extracted from ADS 2004 (2005, 2004, 2003) and reconciled to ONS 2005 (2004, 2003, 2002) estimates for PCTs (special populations such as armed forces, dependents of foreign armed forces; and convicted prisoners who have been inmates for 6 months or more, are excluded).[1]

WTE GPs at March 2005
WTE GPs at March 2005 include GMS unrestricted principals, PMS contracted GPs, PMS salaried GPs, restricted principals, assistant salaried doctors and PMS other. Information on WTE GPs, including registrars and retainers, WTE practice nurses, WTE community nurses and WTE practice staff is not available at March 2005.

Combined age-sex workload and additional need adjustment
The age-sex and need adjustments are those used in the DH Global Sum Allocation Formula (Department of Health, 2004). The raw population is first multiplied by the age-sex workload index. The resulting population is then scaled back so that the sum is equal to the unweighted population of England.

Next the raw population is adjusted by additional need variables (the SLLTI and the SMR) using the following formula:

$$\alpha + \beta_1 \times SLLTI + \beta_2 \times (SMR < 65)$$

in which α, β_1 and β_2 are estimated coefficients respectively equal to 48.1198, 0.26115 and 0.23676 (Department of Health, 2004). The resulting population is then scaled back so that the sum is equal to the unweighted population in England. The age-sex adjusted population is then multiplied by the additional needs adjusted population and scaled back.

[1] The contact we were given at the Information Centre told us that the 2005 GP relevant population extracted from the ADS 2006 and reconciled to ONS mid 2005 estimates is not available at PCT old boundaries level. This explains why for 2005 the GP relevant population is extracted from ADS 2004 (instead of 2006) and reconciled to ONS mid 2005 estimates.

Formally the age-sex index in PCT *i* is given by:

$$ASI_i = \sum_i \sum_j p_{ij} \times \frac{\sum_j w_j p_{ij}}{\frac{\sum_i \sum_j w_j p_{ij}}{\sum_j p_{ij}}}$$

where p_{ij} is the raw population in PCT *i* in subgroup *j* and w_j is the weight given to subgroup *j*. The subgroups with corresponding weights are given below:

	0-4	5-14	15-44	45-64	65-74	75-84	85+
Male	3.97	1	1.02	2.16	4.23	6.01	7.22
Female	3.64	1.04	2.2	3.37	4.95	6.95	8.85

The SMR/LLTI index in PCT *i* is

$$SLI_i = \sum_i \sum_j p_{ij} \times \frac{\alpha + \beta_1 \times SLLTI_i + \beta_2 \times (SMR_i < 65)}{\frac{\sum_i [\alpha + \beta_1 \times SLLTI_i + \beta_2 \times (SMR_i < 65)]}{\sum_j p_{ij}}}$$

where α, β_1 and β_2 are coefficients equal to 48.1198, 0.26115 and 0.23676, respectively, and $SSLTI_i$ and SMR_i are the indirectly standardised limiting long-term illness and mortality (under 65) ratios for PCT *i*. The needs-adjusted population in PCT *i* is calculated as:

$$NAP_i = \sum_i \sum_j p_{ij} \times \frac{ASI_i \times SLI_i \times \sum_j p_{ij}}{\sum_i \left[ASI_i \times SLI_i \times \sum_j p_{ij} \right]}$$

Note that $\sum_i \sum_j p_{ij}$ is the total raw population and $\sum_j p_{ij}$ is the raw population in PCT *i*.

SLLTI adjustment
The raw population is first multiplied by the SLLTI weights and then scaled back so that the sum is equal to the unweighted population in England.

SMR adjustment
The raw population is multiplied by the SMR<65 weights and then scaled back so that the sum is equal to the unweighted population in England.

Information Centre data
Age and gender specific consultation rates
The QRESEARCH database has information extracted directly from the electronic records of patients in over 500 practices. Consultations are the number of contacts between a patient registered with a practice and the clinician. Events where there was no direct contact between the patient and the clinician (GP, nurse or other clinicians) are excluded. Consultation rates are available by age and gender and on a patient-year basis. We use the rates for 2005. We apply the age/sex specific consultation rates to the age/sex mix of the population in each PCT to get an expected number of consultations and then calculate the PCT adjusted population as its expected share of total consultations times the national raw Census population.
Source: http://www.ic.nhs.uk/statistics-and-data-collections/primary-care/general-practice/trends-in-consultation-rates-in-general-practice-1995--2006

Appendix B: Replication of White Paper rankings

The White Paper measure of GPs per head is WTE GPs (including GMS Unrestricted Principals, PMS Contracted GPs, PMS Salaried GPs, Restricted Principals, Assistants Salaried Doctors and PMS Other, but excluding registrars and retainers) divided by weighted population. Weighted population was calculated using the age-sex workload and additional need adjustment applied to the GP relevant population.

The Department of Health supplied us with measure of GPs and with the weighted populations used to calculate the White Paper rankings. We were however unable to reproduce these weighted populations (the denominator in the White Paper GPs per head measure) exactly using separate measures of the age-sex workload, additional needs and GP relevant populations. Neither the Information Centre nor the DH could provide us with the original data to enable us to reproduce the White Paper rankings precisely.

However, our replication of the White Paper denominator is very close. The Pearson correlation coefficient between GPs per head which underly the White Paper and our replication is 0.9995 (N=303) and the Spearman rank correlation coefficient is 0.993 (N= 303).

Moreover our replication GPs per head measure identifies the same set of worst provided 30 PCTs. See Table B1. There is a slight re-ordering of some PCTs as highlighted in bold and shown in the last column of the table.

Table B1: 30 PCTs with lowest GPs per head: comparison of White Paper and replication

PCT	WTE GPs per 100,000 weighted population		Rank	
	White Paper	Replication	White Paper	Replication
North Manchester PCT	40.61	40.59	1	1
Wyre PCT	43.18	42.82	2	2
Ashfield PCT	43.64	43.37	3	4
Trafford North PCT	43.80	43.74	4	5
Swale PCT	43.84	43.37	5	3
Oldham PCT	43.98	44.00	6	6
Mansfield District PCT	44.06	44.06	7	7
Doncaster West PCT	44.20	44.09	8	8
Walsall PCT	44.34	44.28	9	9
Knowsley PCT	44.53	44.54	10	10
Wolverhampton City PCT	44.71	44.73	11	11
Doncaster East PCT	44.95	44.83	12	12
Ashton, Leigh And Wigan PCT	45.09	44.94	13	13
Burnley, Pendle And Rossendale PCT	45.15	45.22	14	15
Barking And Dagenham PCT	45.19	45.09	15	14
Blackpool PCT	45.31	45.37	16	16
North Stoke PCT	45.51	45.68	17	17
Eastern Hull PCT	45.52	45.81	18	19
Wednesbury And West Bromwich PCT	45.66	45.75	19	18
Tendring PCT	46.30	45.85	20	20
Barnsley PCT	46.39	46.26	21	22
Easington PCT	46.45	46.59	22	23
Shepway PCT	46.46	46.03	23	21
Hastings And St Leonards PCT	46.73	46.64	24	24
North Kirklees PCT	46.87	46.78	25	25
Southport And Formby PCT	47.31	47.26	26	26
South Tyneside PCT	47.42	47.56	27	30
Oldbury And Smethwick PCT	47.45	47.51	28	28
Hartlepool PCT	47.47	47.39	29	27
Blackburn With Darwen PCT	47.54	47.55	30	29